A METHOD OF FORECASTING PRECIPITATION 28-40 HOURS IN ADVANCE DURING OCTOBER

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Manuscript Received January 10, 1951]

ABSTRACT

A method is developed and described for forecasting whether measurable precipitation will occur at Washington, D. C., during the daylight hours "tomorrow" using meteorological information which is available to the forecaster during the early morning hours "today," namely the upper air observations taken "yesterday." Methods which the author had previously developed for use during summer and winter months were found ineffective when applied to October data. In the present system the initial assumption is made that rain *will* occur during the specified period. Procedures are then applied for eliminating rain from the forecast. Unless a rule is found which states that rain will not occur, rain is forecast.

Results obtained when the system is applied to Baltimore, Md., and Richmond, Va., using the same variables as used for Washington, D. C., are also shown.

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INTRODUCTION

The research described in this report was initiated following several embarrassing forecast errors during the month of October 1949. Its over-all purpose is to provide a systematic means of preventing, if possible, the recurrence of similar errors. Although forecasters use many methods, which are usually much more complex than pure extrapolation, in forecasting of rainfall for periods 24 to 48 hours in advance, there is little that can be found by way of published material to show just what methods or tools are the most useful. This report is therefore an attempt to set down a method of forecasting to be used during the month of October for Washington, D. C., Baltimore, Md., and Richmond, Va.

It was found that methods used for forecasting summer precipitation [1] and winter precipitation [2] which involved similar time lags met with failure when applied to data for the month of October. However, this is not a surprising result since the broad scale circulation patterns are changing during autumn and do not fit well either the summer or winter normals but are more or less a combination of the two. Thus, shower type precipitation may be expected at times, and during other periods a more general type of precipitation in connection with coastal developments. Moreover, October normally is one of Washington's driest months with an average of 2.91 inches of rainfall as compared with 4.42 inches for August and 3.32 inches for January. It averages fewer days with measurable precipitation than any summer or winter month. However, monthly totals have been as much as 8.81 inches and the greatest 24-hour amount was 3.98 inches.

SELECTION OF PROBLEM AND DATA

Forecasts for "tomorrow" issued from the 0130 EST surface map of "today" are considered to be of major importance because of the widespread dissemination given to them and the large amount of operational planning based on the forecasts issued during the early morning. There are many operations contingent on "daytime" weather for tomorrow as well as today's weather. Thus one's reputation as a successful forecaster for any specific location depends a great deal on maintaining a good record in forecasting tomorrow's daytime weather. The problem selected for study is therefore the prediction of whether or not measurable rain will occur at Washington, D. C., during the hours 0700 through 1900 EST "tomorrow."

At the time of issuing the forecast for which this study is designed as an aid, the forecaster has available to him the surface or sea level weather map for 0130 EST and the analyzed upper air charts for 2200 EST of the preceding evening. This investigation is limited to the systematic utilization of data from the 2200 EST upper air charts and reference to surface weather conditions has been omitted except wherein it may aid in clarification of the text. The forecaster is left to his own devices in applying the surface data or in otherwise modifying the objective forecast of "rain" or "no rain."

Surface data are not used for several reasons. First, it was decided to determine the extent to which upper air information alone could be used in making a forecast for the selected 12-hour period. Second, if a forecast method is to be of maximum practical use it should be a method that can be used before the last few minutes of the forecaster's allotted time. Since the upper air information is all available before the surface map, the forecast based on the upper air information can be completed before the surface map is analyzed. Thus the system is in part designed to fit the operational program of a forecast center which issues forecasts for a broad area, the deadline for which is not long after the completion of the surface weather map. During this brief period, time is not available for the application of objective systems for more than a small portion of the area for which forecasts must be issued. It is possible that the addition of surface parameters could improve the system described in this study, but in a limited attempt to do this, no additional advantages were gained. In many of the cases studied precipitation or surface disturbances developed after the forecast deadline so that extrapolation of surface information was not helpful.

The results might actually suggest that for forecasts as far in advance as those discussed here, the surface data can contribute little information in addition to that supplied by the upper air.

The basic and test data used in this study include all Octobers 1945 through 1949. Data were not readily available for years prior to 1945 and since this study was started after September 1, 1950, and the objective was to develop a system that could be used beginning October 1, 1950, a limited amount of time was available. Years 1945, 1947, and 1949 were used as dependent data and years 1946 and 1948 as test data. The study in which 155 individual cases were examined was completed and made available for use by the regular forecasters at Washington National Airport prior to October 1, 1950. The results when applied to October 1950 were very encouraging and the hope is that the system can be made even better with further investigation.

DEVELOPMENT OF FORECASTING SYSTEM

METHOD OF APPROACH

In selecting variables which might be related to the actual occurrence of precipitation during the 12-hour period beginning 33 hours after the most recent (2200 EST) upper air soundings, it was soon discovered to be extremely difficult, by the specified forecast deadline time, to delineate the necessary conditions for measurable rain to fall during the period in question. Of course, timing or movement of systems was extremely important, i. e., if conditions moved too fast rain would end before beginning of the period, or, if too slow then rain would not begin until after the end of the 12-hour period. After many attempts to base the forecast of rain on a number of "causal factors" it was decided that this method was not appropriate during the month of October but that much better results might be obtained by determining what factors would *prevent* occurrence of rainfall during the period. Thus, lacking a "preventative" factor, rainfall was likely during the period in question. Although some meteorologists are perhaps not accustomed to thinking of forecasting in the sense of determining that certain conditions such as rainfall will *not* occur, it is usually a part of the forecaster's "thought process" whether he realizes it or not. For example, a forecaster in checking the latest synoptic charts, determining movement, deepening, filling, etc., and deciding whether a given system will produce rain, must also go through the process of determining whether or not this particular rain development will have passed through or be short of, north of, south of, etc., the forecast area during the period in question.

STRATIFICATION OF WEATHER SITUATION

As stated previously, the method being described involves the use of upper air data read from constant pressure charts at 850 mb. and higher. At the outset many of the situations were eliminated as "no rain" cases by the simple device of indexing the flow pattern west of Washington at 850 mb. This was done by noting the height of this surface at Nashville, Tenn., and Sault Ste. Marie, Mich., both as compared with the height at Washington, D. C., at the corresponding time, 2200 EST. (See fig. 1.) Thus if heights at both Nashville and Sault Ste. Marie are higher than at Washington a broad northwesterly flow usually is present west of Washington, which normally prevents the occurrence of a precipitation-producing situation in the Washington area during the period 33–45 hours hence. A second type, wherein the height at Nashville is less than Washington and that at Sault Ste. Marie is greater than Washington, often precedes the occurrence of rain at Washington and therefore further factors must be checked in order to determine whether a rain-producing system will be influencing the Washington area during our 12-hour forecast period. The third type, which meets neither of the above conditions, and therefore includes all cases not classified as one of the first two categories requires a more detailed check. (See fig. 1.)

Table 1 outlines roughly the problem which remains after this stratification, and in the sections which follow methods for forecasting are described in greater detail under the corresponding type.

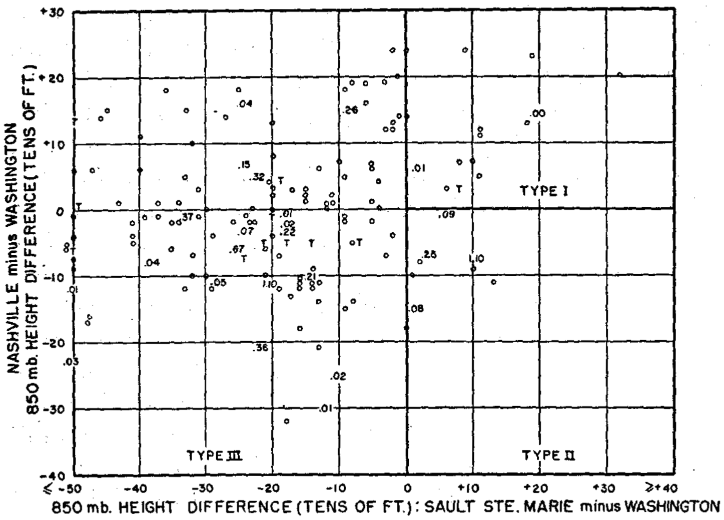

FIGURE 1.—Scatter diagram showing distribution of cases considered in the study as a function of two 850-mb. height differences, and stratification into three basic types. For the plotted cases, open circle indicates no rain during forecast period, "T" indicates trace of rain, and number indicates measurable amount of rain (inches).

Table 1.—Stratification of October cases 1945–49 into three basic types

Type	Number of cases	Number of "rain" cases	Frequency of rain (%)
I	13	2	15
II	8	4	50
III	134	19	14
All types	155	25	16

TYPE I PROCEDURE

Type I includes all instances wherein the 850-mb. height at Nashville and the 850-mb. height at Sault Ste. Marie are both greater than that at Washington. With this type, a forecast of "no rain" is usually sufficient (and in an objective application of the system, always indicated) since northerly or northwesterly flow is usually present aloft in such a way as to prevent a trough from being sufficiently close 33–45 hours in the future to bring in the necessary moisture, vertical motion, etc., to produce precipitation.

TYPE II PROCEDURE

In type II cases the 850 mb. height at Nashville is lower than at Washington and that at Sault Ste. Marie is greater than at Washington.

This type usually occurs along with a low pressure system which is threatening to move into the Washington area from the south, and is an ideal type for the production of heavy amounts of rain at Washington. Rain usually occurs at Washington subsequent to map time (0130 EST), though it may either move too fast to still be occurring during the forecast period, or the entire rain producing system may be displaced south of our area. These two possibilities are covered by the following rules:

1. If the 850-mb. heights at Omaha, Sault Ste. Marie, and Washington show 24-hour rises, forecast "no rain" as any rain producing system will be pushed south of our area.
2. If Washington shows a greater 24-hour height fall than Nashville at 850 mb. and there are no falls west and northwest of Nashville (at Omaha, Little Rock, Chicago, and Columbia) greater than the Nashville fall, forecast "no rain" since the entire rain-producing system, if any, will move through before the beginning of the forecast period.

TYPE III PROCEDURE

Of the 155 cases examined in this study, 134 or 87 percent were type III. Type III consists of all cases not previously classified as type I or II and by definition includes all cases wherein the 850-mb. height at Sault Ste. Marie is equal to or less than that at Washington.

Forecasting whether rain will occur with this type of situation is again essentially an elimination process. Thus most of the steps in the forecasting procedure outlined here involve the question of whether rain can be eliminated. It follows therefore that if one reaches the end of the list of proposed questions without eliminating rain, the forecast should be for rain to occur within the specified 12-hour period "tomorrow."

1. Follow the 700-mb. contour through Washington upwind. If this contour is through or north of Chicago *and* Omaha forecast "no rain." Otherwise check step 2.
2. If the 850-mb. surface at Nashville is 30 feet or more higher than that at Miami, forecast "no rain." Otherwise check step 3.
3. Next follow the 850-mb. contour through Nashville upwind. If this contour is through or north of Oklahoma city, follow steps shown below under *North Type.*[1] Otherwise follow the steps shown under the heading *South Type.*

North Type (Nashville 850-mb. contour upwind is through or north of Oklahoma City.)[1]

(a) If there is a trough at 500 mb. between the Rocky Mountains and Chicago, check step (b). Otherwise forecast "no rain."

(b) If the trough at 500 mb. exists, check the 500-mb. contour through Greensboro, N. C., upwind. If it extends southward to below the 30th parallel (30° N. latitude),[2] check step (b.1). Otherwise check step (b.2).

(b.1) (500-mb. contour through Greensboro upwind goes south of 30° N.) If the 24-hour height tendency at 700 mb. over Oklahoma City

[1] On occasion the Nashville contour extends directly northward or northeastward rather than northwestward as might be pictured here. Such cases are also classified as being the *North Type*.

[2] Little difficulty should be encountered here, even though a strict definition of the longitudinal limits is not given. Roughly it is that portion of the 30th parallel between 75° and 115° W. longitude which is being considered.

is negative *or* if the 24-hour height tendency at 850 mb. at Little Rock is negative, forecast "rain." Otherwise forecast "no rain."

(b. 2) (500-mb. contour through Greensboro upwind stays north of 30° N.) Check the 24-hour height tendencies at North Platte, Dodge City, and Oklahoma City at 850 mb., 700 mb., and 500 mb. If two of three stations show minus tendencies at all three levels forecast "rain." Otherwise forecast "no rain."

South Type. (Nashville 850-mb. contour upwind is not north of or through Oklahoma City.)

(a) Check 850-mb. 24-hour height changes at Nashville and Chicago. If Chicago height is falling and that at Nashville rising, forecast "no rain."

(b) Check 24-hour height changes at 850 mb. at Minneapolis, Omaha, Dodge City, Little Rock, and Nashville. If they are all rises, forecast "no rain," *except* if the 850-mb. and 700-mb. contours through Toledo upwind enter the Gulf of Mexico, check step (c).

(c) If step number 2 (above) showed 850-mb. surface at Nashville to be 10 or 20 feet higher than at Miami and if Chicago 850-mb. height is greater than Miami, forecast "no rain."

(d) If the 850-mb. contour through Washington upwind is through or north of Albany or north of Buffalo and International Falls, forecast "no rain."

(e) If the height of the 850-mb. surface at Atlanta is 30 feet or more higher than that at Nashville and Miami, and the 700-mb. contour through Nashville upwind is through or north of Fort Worth, forecast "no rain."

If (a), (b), (c), (d), or (e) does not eliminate rain, then the forecast must be "rain."

For the reader who is concerned by the elaborate treatment given to type III cases as compared with the automatic "no rain" forecast for type I cases, one need perhaps mention only the far greater number of type III cases available for study. Furthermore in the two rain cases subsequent to type I maps, amounts of rain measured at Washington were very light, 0.01 and 0.05 inch for the 12-hour period.

METEOROLOGICAL REASONING IN TYPE III RULES

Because the forecasting system for use in type III cases is elaborate, a discussion of the meteorological reasoning involved in its development may help other forecasters to relate the rules to their own forecasting experience. The numbering of the following paragraphs corresponds to the type III rules listed in the preceding section.

1. If Washington upwind flow at 700 mb. is through or north of Chicago and Omaha there is usually insufficient time for an air channel from the Gulf to "open" and permit moisture to arrive in the Washington area along with other conditions conducive to formation of precipitation within 45 hours.

2. When Nashville 850-mb. height is 30 feet or more greater than Miami the flow aloft ordinarily holds waves, overrunning, etc., to the east and south of Washington during the verification period and there is usually insufficient time for rain to develop and move in from the west or southwest.

3. North Type Cases:
When the Nashville 850-mb. upwind flow is through or north of Oklahoma City any rain producing troughs in the eastern half of the country usually move too far east to cause precipitation in the Washington area during the verification period. However, when troughs "hang back" considerably at upper levels, and pressure falls (height falls) are introduced into these troughs, waves or new fronts develop under certain conditions and clearing does not take place as soon as when these conditions do not exist. The rules listed under the *north type* cases are for the purpose of detecting the cases which will produce rain when a trough at 500 mb. is lagging as far back as the Chicago–Denver area.

South Type Cases:

(a) This rule was developed to take care of disturbances moving in a northeastward direction in such fashion that rain will usually be confined to areas north of Washington and Baltimore or if rain occurs it will usually have ended before forecast period.

(b) This rule serves generally to take care of filling and/or sufficient eastward movement of a trough so as to rule out rain.

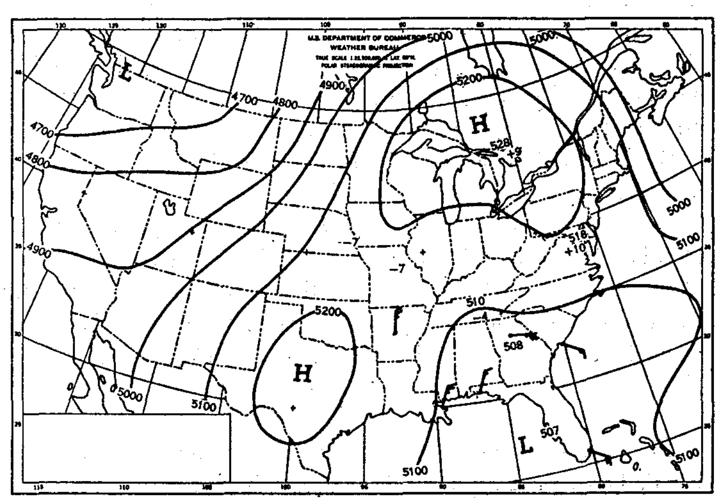

FIGURE 2.—850-mb. chart for 2200 EST, October 3, 1948. Contours are drawn for 100-ft. intervals and labeled in feet. Three-digit numbers plotted at selected stations give observed height in tens of feet, and the numbers preceded by + or − indicate the 24-hour height change at the stations.

(c) This is similar to rule 2 above and since 10 or 20 feet is more or less in the transitional zone between 0 and 30, it was considered advisable to include an additional variable, making two conditions necessary to eliminate precipitation.

(d) Again in this case there is usually a strong northerly flow caused by a Low just moving off the coast at map time and there is insufficient time for another disturbance to move into the area by the beginning of the forecast period.

(e) This implies a blocking High in the East and relatively dry flow into Nashville at 700 mb.

EXAMPLES OF APPLICATION

The examples of application of the forecasting system to actual situations which are given in this section may help clarify any questions the reader may have about the procedures for types II and III.

EXAMPLE OF TYPE II CASE

The 850-mb. chart for 2200 EST, October 3, 1948 (fig. 2) shows Nashville height at 5,100 feet, Washington 5,180 feet, and Sault Ste. Marie 5,280 feet. Since Nashville is lower than Washington and Sault Ste. Marie higher than Washington this falls into the type II category, which is the rain type. The steps in forecasting are as follows:

1. Omaha 24-hour height change is negative, therefore rain is not eliminated.
2. Washington 24-hour height change is "plus" and Nashville "minus," therefore this does not eliminate rain.

Since these two steps do not eliminate rain the system automatically gives a "rain" forecast.

A study of the surface map for 0130 EST, October 4 (fig. 3) reveals that at the time the forecast was made there was a nearly stationary front extending from northern Florida eastward to near Bermuda; this front had been in northern Florida for nearly 24 hours. A large high pressure system was located over the Great Lakes with a ridge extending southward to Texas. Measurable rainfall had occurred in central and southern Georgia but little or no rain from northern Georgia northward.

By 0130 EST, October 5 (fig. 4) a well developed wave had formed and was located just south of Hatteras and rain was just beginning in Washington. By 1930 EST, October 5, the rain had spread northward through all of Pennsylvania and the total fall at Washington during the 12-hour verification period was 1.10 inches. Rainfall at both Richmond and Baltimore was 1.15 inches.

EXAMPLES OF TYPE III CASES

The case shown on the constant pressure charts for 2200 EST, October 26, 1949, from which a forecast for the "day" period of October 28 was made, provides considerable interest. Heights on the 850-mb. chart in figure 5 show that the height at Sault Ste. Marie is less than that at Washington. (Washington 5,100 ft. and Sault Ste. Marie 4,880 ft.) This classifies the situation as type III.

The surface map available at forecast time is the 0130 EST map of October 27 (fig. 6). The surface map is not used in this system but it will be interesting to note that

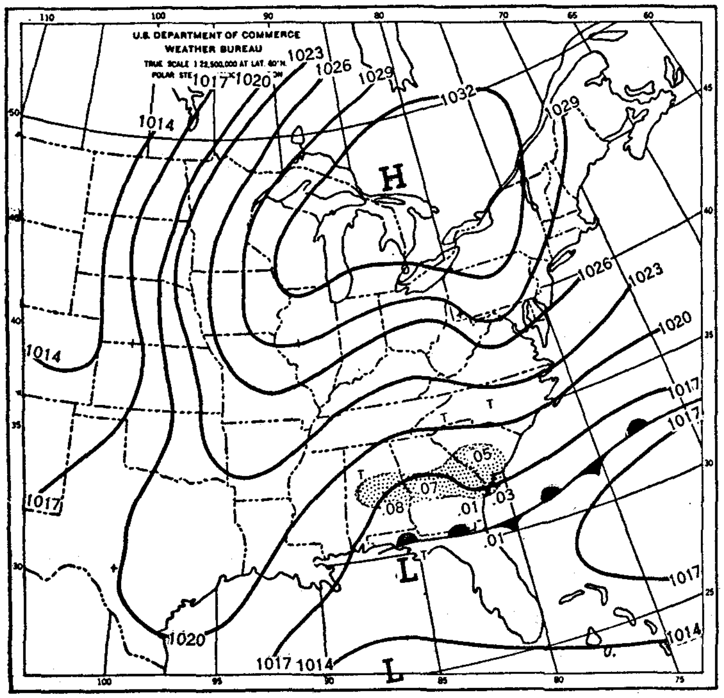

FIGURE 3.—Surface chart for 0130 EST, October 4, 1948. Isobars are labeled in millibars. The stippling indicates area of active precipitation, and plotted numbers show 6-hour amounts at selected stations.

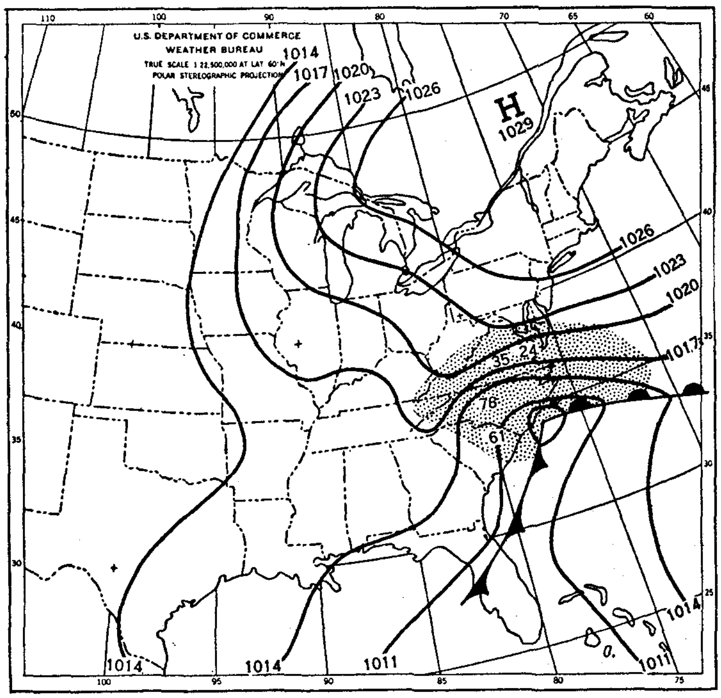

FIGURE 4.—Surface chart for 0130 EST, October 5, 1948.

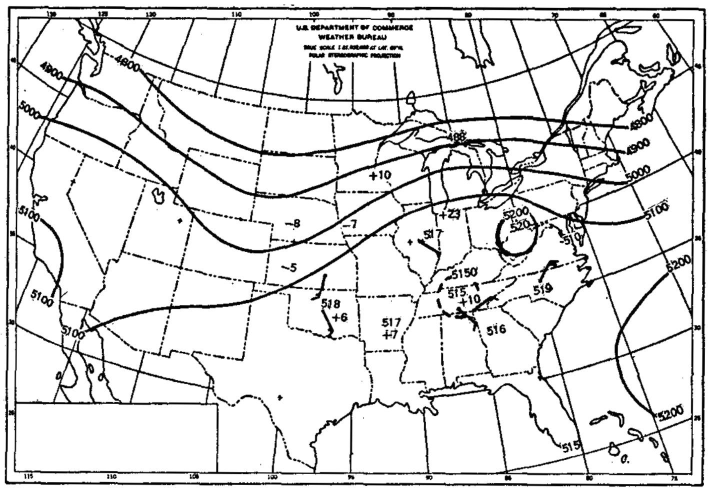

FIGURE 5.—850-mb. chart for 2200 EST, October 26, 1949.

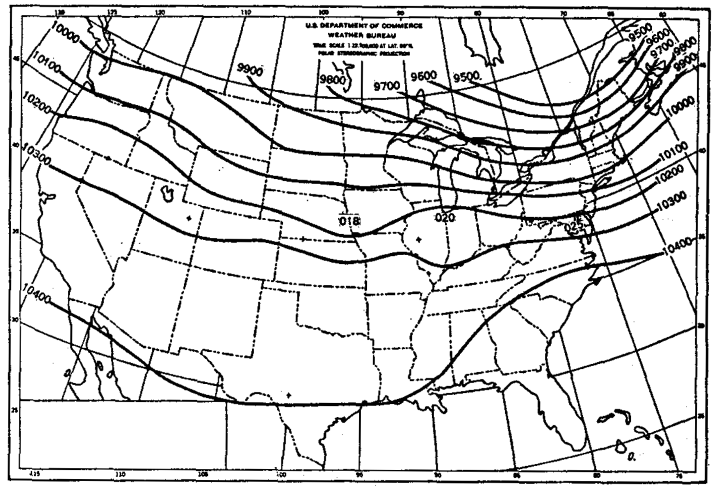

FIGURE 7.—700-mb. chart for 2200 EST, October 26, 1949. Contours are labeled in feet. Plotted numbers selected stations give observed height in tens of feet (with the 10-thousand digit omitted).

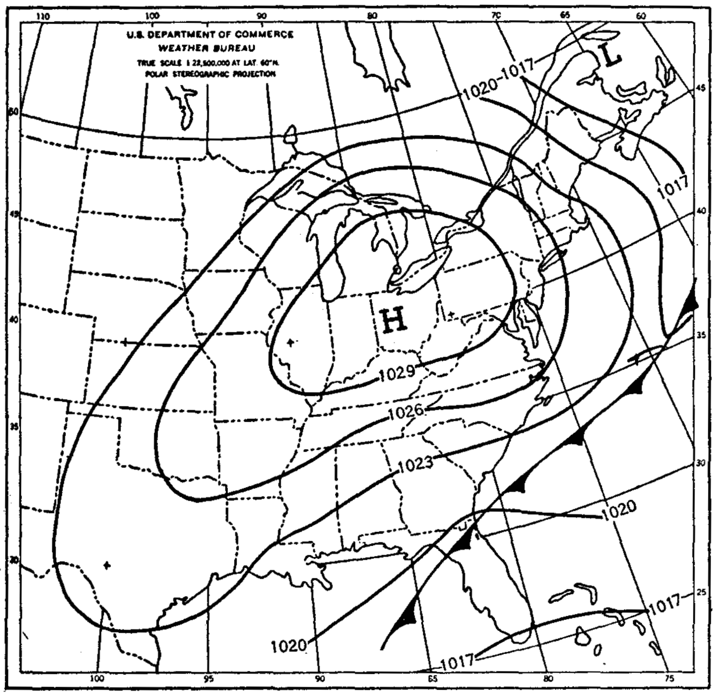

FIGURE 6.—Surface chart for 0130 EST, October 27, 1949.

a large high pressure system covers the eastern half of the country and a cold front is well east of Washington and extending southwestward to near Jacksonville. The air is quite dry over the east and pressures are rising and the cold front has had an eastward movement of 30 to 40 m. p. h. during the past 12 hours. In this case it appears perfectly logical to forecast "no rain" for tomorrow. The 700-mb. chart for 2200 EST of the 26th is shown in figure 7.

The check of steps in forecasting for type III cases as applied here follows:

1. Washington 700-mb. upwind flow is south of Chicago and Omaha, therefore check step 2.
2. Nashville 850-mb. height (5,150 ft.) is not 30 feet or more higher than Miami (5,150 ft.); therefore we must proceed further.

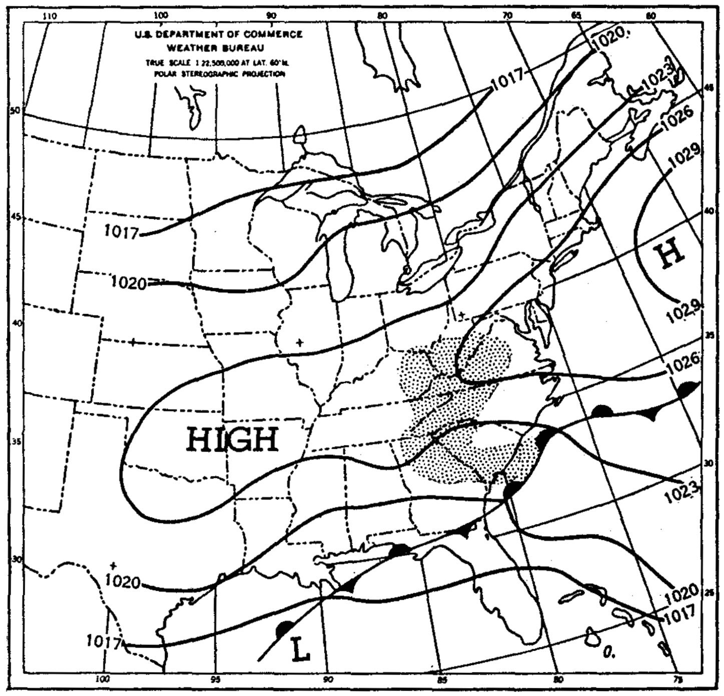

FIGURE 8.—Surface chart for 1330 EST, October 28, 1949.

3. Nashville 850-mb. upwind flow is not through or north of Oklahoma City, therefore this is classified as a *South Type*.
   (a) Chicago 24-hour height change is plus, so this does not eliminate rain.
   (b) Dodge City and Omaha 850-mb. heights are falling, so this does not eliminate rain.
   (c) Does not apply and does not eliminate rain.
   (d) Washington 850-mb. upwind flow is south of Albany, Buffalo, and International Falls, so this does not eliminate rain.
   (e) Atlanta 850-mb. height (5,160 ft.) is only 10 feet higher than Nashville (5,150 ft.) and Miami (5,150 ft.), so this does not eliminate rain.

Since rain is not eliminated the system then indicates a forecast of rain.

The surface map for 1330 EST, October 28 (fig. 8), shows that the cold front which had passed Washington early on the 27th later became stationary and then had a wave develop south of Hatteras. In turn, precipitation formed and spread well north of Washington during the last 6 hours of the verification period, giving Washington a rainfall of 0.32 inch, Richmond 0.12 inch, and Baltimore 0.09 inch.

Another type III example is shown in figures 9, 10, 11, 12, and 13 consisting of constant pressure maps for 2200 EST, October 22, 1949, along with surface maps for 0130 EST, October 23 and 1330 EST, October 24. From figure 9, it is apparent at a glance that the 850-mb. height at Sault Ste. Marie (4,520 ft.) is less than that at Washington (4,970 ft.) and therefore this is classified as type III.

The surface map for 0130 EST, October 23 (fig. 10) shows a cold front extending from Nantucket to New Orleans. During the past 6 hours its movement eastward has not exceeded 20 m. p. h. Another trough is approaching from the Upper Lakes region. Forecast steps are as follows:

1. Washington 700-mb. upwind flow (fig. 11) is south of Chicago and Omaha, therefore check next step.
2. Nashville 850-mb. height (5,120 ft.) (fig. 9) is not greater than Miami (5,150 ft.), therefore check next step.
3. Nashville 850-mb. upwind flow is north of Oklahoma City therefore this is a *North Type.*
   (a) There is not a trough at 500 mb. (fig. 12) between Chicago and Denver; therefore the forecast is for "no rain."

The surface map for 1330 EST, October 24 (fig. 13) shows that rain did develop in Tennessee and Kentucky and spread into the southern portion of West Virginia, but no rain occurred in Virginia or Maryland during the verification period.

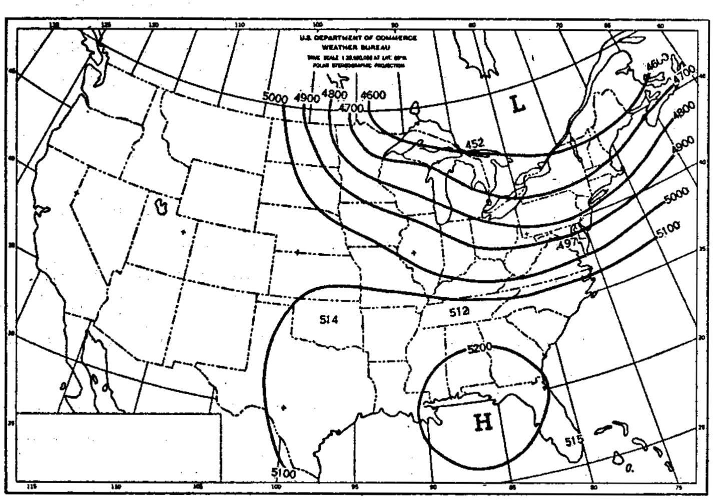

FIGURE 9.—850-mb. chart for 2200 EST, October 22, 1949.

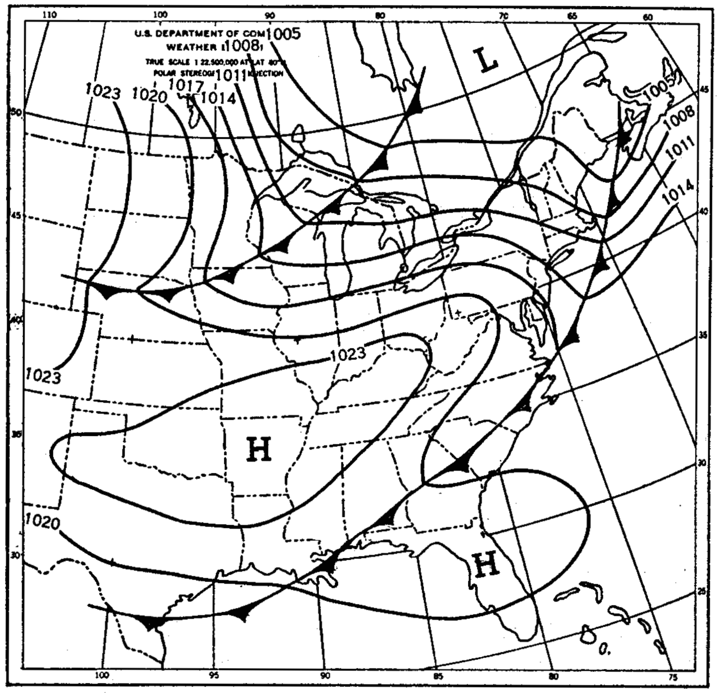

FIGURE 10.—Surface chart for 0130 EST, October 23, 1949.

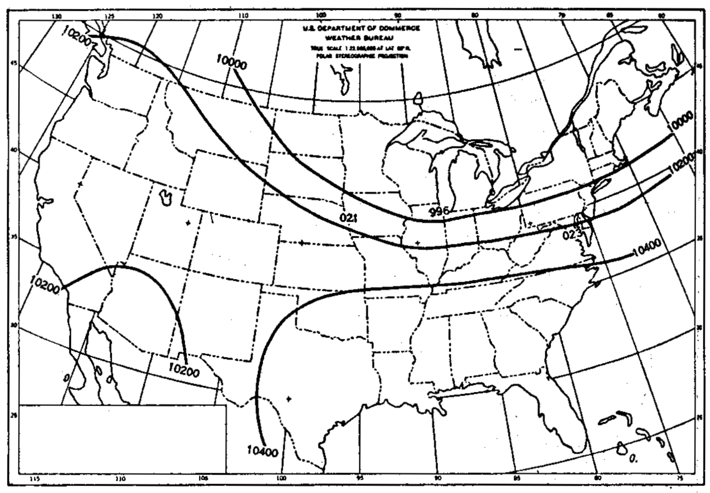

FIGURE 11.—700-mb. chart for 2200 EST, October 22, 1949.

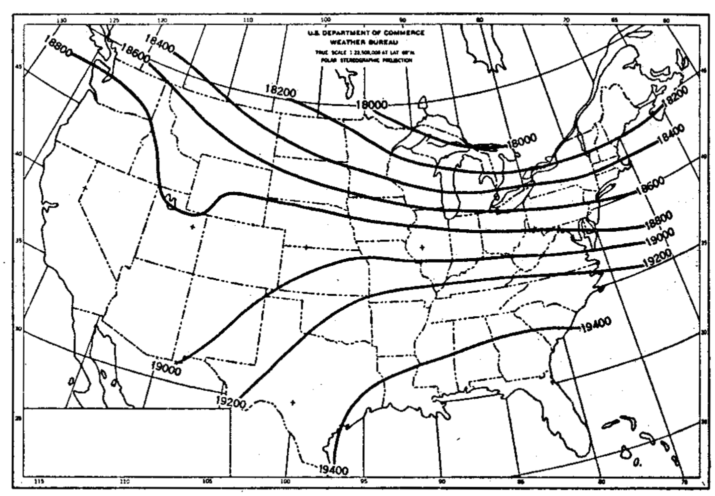

FIGURE 12.—500-mb. chart for 2200 EST, October 22, 1949. Contours are labeled in feet.

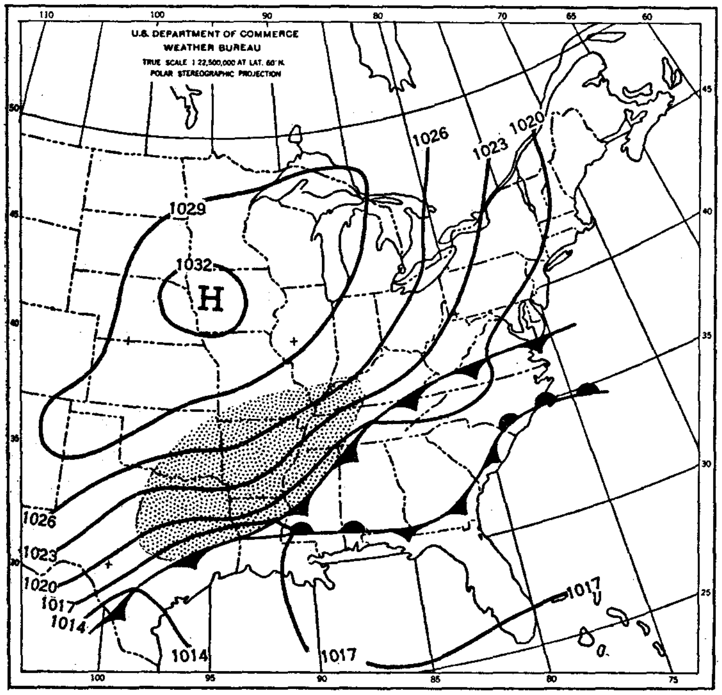

FIGURE 13.—Surface chart for 1330 EST, October 24, 1949.

RESULTS OF TESTING

A rigid verification, considering measurable rain (≥ 0.01 inch) at Washington as verifying a "rain" forecast and no precipitation or a "trace" as verifying a "no rain" forecast, shows an over-all percentage of 88 percent correct forecasts for all cases during the 5 years included in the basic and test data. The results for Washington, including comparison with official forecasts made during the same period, are shown in table 2.

TABLE 2.—*Contingency tables showing results of system forecasts for Washington, D. C., for basic and test data, and results of official forecasts for the same period*

Basic data, October 1945, 1947, 1949		Official forecast			Test data, October 1946, 1948		Official forecast		
		Rain	No rain	Total			Rain	No rain	Total
Observed	Rain	3	12	15	Observed	Rain	7	3	10
	No rain	11	67	78		No rain	4	48	52
	Total	14	79	93		Total	11	51	62
Percent correct = 75 Skill score = 0.08					Percent correct = 90 Skill score = 0.61				
		System forecast					System forecast		
		Rain	No rain	Rain			Rain	No rain	Total
Observed	Rain	12	3	15	Observed	Rain	9	1	10
	No rain	9	69	78		No rain	5	47	52
	Total	21	72	93		Total	14	48	62
Percent correct = 87 Skill score = 0.60					Percent correct = 90 Skill score = 0.70				

Although this system was developed specifically for the Washington area it should also give reasonably good results when applied to Baltimore and Richmond, as these cities are sufficiently close to Washington that it is usually rather difficult to determine whether a rain area affecting Washington 33–45 hours in the future will or will not affect Baltimore or Richmond. However, there are some situations which result in rain-producing systems moving to the north of Washington giving rain at Baltimore and Washington, and there are others moving close to the south which produce rain at Richmond and Washington but just miss Baltimore. It is very interesting to note that when the same rules are applied to Richmond and Baltimore as developed for Washington the results give identical percent scores for the 5 years included in this study, that is 85 percent as compared with 88 percent at Washington. The results for Baltimore and Richmond are summarized in table 3.

TABLE 3.—*Contingency tables showing results of system forecasts for Richmond, Va., and Baltimore, Md., for basic and test data*

Basic Data, October 1945, 1947, 1949					Test Data, October 1946, 1948				
Richmond		System forecast			Richmond		System forecast		
		Rain	No rain	Total			Rain	No rain	Total
Observed	Rain	12	5	17	Observed	Rain	8	3	11
	No rain	9	67	76		No rain	6	45	51
	Total	21	72	93		Total	14	48	62
Percent correct = 85 Skill score = 0.53					Percent correct = 85 Skill score = 0.55				
Baltimore		System forecast			Baltimore		System forecast		
		Rain	No rain	Total			Rain	No rain	Total
Observed	Rain	10	4	14	Observed	Rain	9	3	12
	No rain	11	68	79		No rain	5	45	50
	Total	21	72	93		Total	14	48	62
Percent correct = 84 Skill score = 0.48					Percent correct = 87 Skill score = 0.62				

RESULTS OF APPLICATION IN OCTOBER 1950

As was stated earlier the method described in this report was completed and tested prior to October 1, 1950, in order that it might be available for use in actual forecasting at that time. It is therefore of considerable interest to examine the results obtained during that month, which in addition to being a month which could logically be reported as test data, is a month wherein the computations were actually routinely performed by the forecasters responsible for the issuance of the official forecasts for the period under consideration. The contingency table shown in table 4 indicates the results thus obtained.

Identical contingency tables were obtained when the results of applying the system to Baltimore and Richmond

TABLE 4.—*Contingency table showing results of system forecasts for Washington, D. C., from routine application during October 1950*

		System forecast		
		Rain	No rain	Total
Observed	Rain	3	2	5
	No rain	1	25	26
	Total	4	27	31
Percent correct=90 Skill score =0.62				

were analyzed, even though there was a slight difference in the actual dates on which precipitation was reported at Richmond as compared with Baltimore and Washington. It is readily seen that the objective forecasts for Washington were 90 percent correct when applied not only to Washington but also to Richmond and Baltimore.

CONCLUSIONS

The results of this and other studies of this kind which have been referred to in the introduction to this report suggest the possibility that very significant improvement in the accuracy of forecasts of tomorrow's weather can be achieved through a systematic utilization of upper air data within the framework of our present knowledge of basic meteorological processes. Even though there has been but casual reference to the surface weather chart in this report, the author believes that the forecaster should continue to strive to see tomorrow's weather in terms of a more complete picture, beyond that contained in the decision of whether or not measurable precipitation will occur within a given 12-hour period. It is hoped that these results can contribute to both.

ACKNOWLEDGMENTS

The author wishes to gratefully acknowledge the encouragement received throughout this investigation from Dr. F. W. Reichelderfer, Chief of the U. S. Weather Bureau, who has continually urged forecasters in the field to actively participate in research efforts toward improving the forecasts of tomorrow's weather.

Thanks are also due to Mr. Conrad P. Mook, Research Forecaster in the Washington Forecast District, for his assistance in the preparation of this report, and to all members of the forecast staff of the Washington District Forecast Center for their wholehearted interest and encouragement throughout all phases of this study.

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